Collider-Accelerator Department
Hazard Screening Report for EBIS Project

Compiled by

Edward T. Lessard

Revision 2

April 24, 2006

Hazard Screening Report for EBIS Project

Introduction

A hazard-screening tool (Appendix 1) was designed to assist in identifying the hazards associated with each sub-system for the EBIS Project to determine the level of hazard analysis required and follow-up actions. The tool was used by each sub-system manager.

In the sections that follow, the EBIS sub-system is listed (first level or one dot), with detail in some cases down to three levels (three dots). This is followed by a summary of the hazards identified using the hazard-screening tool, with an associated hazard rating. Also included are follow-up assignments that must be completed by the sub-system manager. These assignments have a designated responsible individual and are tracked in the C-AD Family Action Tracking System.

In Figure 1, the overall 'hazard-analysis-process' at C-AD is shown. The hazard-screening step, which is one of the initial steps in the 'hazard-analysis-process', is represented by the blue box in the figure. This report documents the hazard-screening step and the action assignments that resulted from that step. The C-AD Family Action Tracking System will be used to track hazard-screening step actions.

Resolutions to actions identified during other steps in the overall 'hazard-analysis-process' will be documented several ways. See OPM Chapter 9 for committee procedures and SBMS Accelerator Safety Subject Area for details. This documentation will include:

- Safety committee minutes
- Facility drawings
- Work packages
- Operations procedures
- Start-up check-off lists
- Documents showing resolution of items from internal reviews
- Documents showing resolution of Accelerator Readiness Review items
- Interlock system installation and testing documentation, if any
- Commissioning procedures for beam operation
- Operator or system specialist training and qualification records
- Shielding drawings
- Radiation monitoring documentation
- Fire hazards analysis
- Quality assurance documents
- Fault study plan
- Accelerator Safety Envelope
- Commissioning plans

In the overall 'hazard-analysis-process', many forms of documentation will be completed to explain the basis of an issue and the basis for any follow-up action. The C-AD ESHQ Division will maintain a centralized record of this documentation for auditing purposes, as per requirements in C-AD OPM 13.4.2 Records Index.

Work planning will be used throughout construction, commissioning and operations in order to address hazards and controls for each job each day. Work planning at a minimum consists of a pre-job briefing and a work-site walk-down. This is done to prepare workers for what is to be accomplished that day and to sensitize workers for what is to be avoided. Post-job reviews and formal Job Risk Analyses will be documented as required. Greater details regarding work planning can be found in C-AD OPM 2.28 C-A Procedure for Work Planning and Control for Operations.

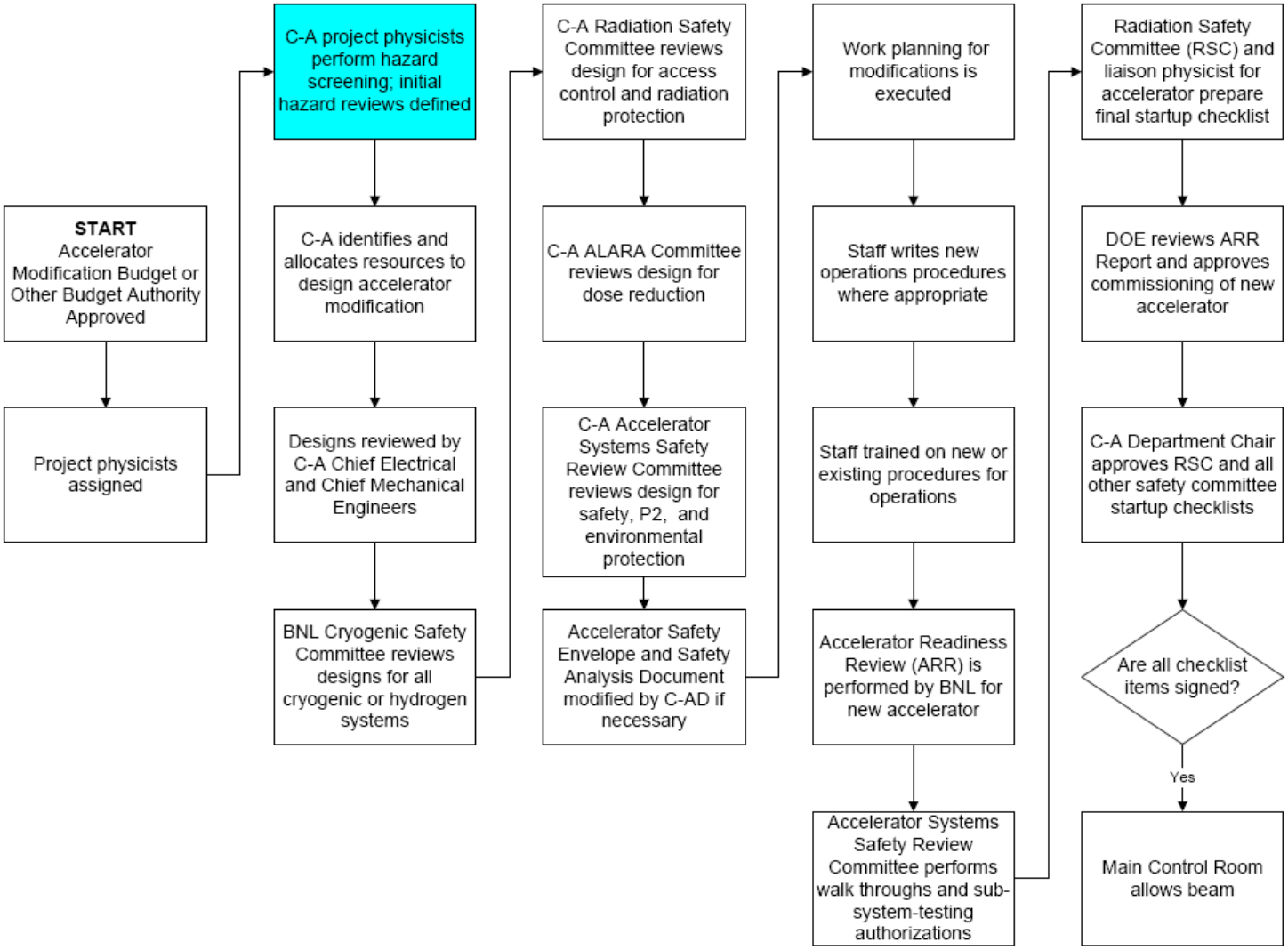

Figure 1 Accelerator Hazard Analysis Process

Executive Summary

Details of the proposed hazards and the follow-up safety review actions are described in this report. Responsible persons are identified. All follow-up actions identified in this screening report will be tracked to closure.

The hazards and controls for EBIS subsystems have been found to be similar to hazards and controls described in the existing C-AD Safety Assessment Document. C-AD occupational safety and health (OSH) programs and environmental (E) programs to be employed at the activity level are described in detail on the C-AD ESHQ web and compared to the Integrated Safety Management System for DOE. These OSH and E programs will be adhered to throughout the construction, commissioning and operation of the EBIS.

EBIS facilities or modifications have undergone a National Environmental Policy Act (NEPA)/Cultural Resources review. This review was conducted separately from this hazard screening.

EBIS Subsystems (Sub-system Manager), Associated Hazards and Follow-up Actions

1.1 Structural Components (E. Beebe)

Structural components consist of the following:
- EBIS Hardware
- LEBT and External Ion Injection
- RF Structures

The major structural components will be installed in the EBIS facility in Building 930.

1.1.1 EBIS Hardware

The following mechanical components comprise the EBIS source.

1.1.1.1 Superconducting Solenoid

The superconducting solenoid is a major element of EBIS and its function is to focus the electron beam generated in the electron gun and maintain its diameter in a region of the ion trap. No shielding is planned for the solenoid in order to enable use of its magnet field "tails" for the electron beam transmission in areas where use of other coils is difficult. The solenoid is located on the EBIS platform and it should require minimum maintenance for refilling of cryogens.

1.1.1.2 Electron Gun

The EBIS electron gun generates the electron beam used for the ionization and confinement of ions in a trap. Since the electron beam propagates through the areas with very low potentials and with different magnetic fields, the requirements on the laminarity of the electron beam are high. For this reason, the magnetic field on the cathode is high enough to determine formation of the electron beam in a cathode-anode gap. The cathode material (Ir-Ce) provides high emission current density with a lifetime of several thousand hours. The electron gun chamber is separated from the rest of the EBIS by two gate valves, which in a case of gun failure allows replacement of whole gun unit by a new one without venting the gun chamber and venting only small buffer volume between gate valves.

1.1.1.3 Drift Tube and Chamber Structures

Drift tubes are installed along the EBIS axis to control ion trap operation and propagation of the electron beam. Drift tubes are electrically isolated from the ground and connected to the external power supplies via electrical feedthroughs in a vacuum jacket. Vacuum chambers form a vacuum envelope around the EBIS with the pressure of residual gas in the range of $1x10^{-10}$ Torr. Three gate valves separate different parts of the EBIS for maintaining high vacuum in parts that are not vented during modification or repair.

1.1.1.4 Stands and Platform Hardware

This includes the mechanical support structures for the EBIS, the electron gun, the LEBT line, and the external ion sources. It also include the 100 kV insulating platform for the EBIS source and its associated power supplies, as well as the electrical system required to put a ramp on the EBIS trap electrodes for fast ion extraction.

1.1.2 Low Energy Beam Transport (LEBT) and External Ion Injection

These are the beam lines between the EBIS output and RFQ input.

1.1.2.1 LEBT

The LEBT is a transitional portion of the pre-injector and is used for:

- Transmission and forming for the injection into RFQ of the ion beam extracted from the EBIS
- Transmission of the ion beam from the external ion injector into the EBIS
- Diagnostic measurements of the ion beams
- Vacuum pumping of the electron collector

The LEBT consists of two vacuum chambers separated by a gate valve; it contains optical electrostatic elements (deflectors, lenses), magnetic lenses for focusing the ion beam into the RFQ and diagnostic elements.

1.1.2.2 External Ion Injection

A set of two or more ion sources generating low charge state ions for injection into EBIS. This also includes ion optics, a switching station for electronically selecting the desired ion species for ion injection, ion current monitors, vacuum system and power supplies.

1.1.3 RF Structures (J. Alessi)

Resonant cavities used to accelerate or decelerate, for bunching, the ion beam. When radiofrequency power is fed into these resonant cavities, the appropriate electric fields for acceleration or deceleration are produced.

1.1.3.1 RFQ

The Radio Frequency Quadrupole (RFQ) is a resonant structure in which four long, continuous vanes or rods, machined with precise modulations and configured in a quadrupole geometry, provide bunching, focusing, and acceleration of the injected ion beam. This type of structure is able to provide efficient rf acceleration at the low energies ion beams have when initially extracted from an ion source. A 4-rod RFQ operating at 101.28 MHz is planned.

1.1.3.2 Linac

The Linac is a resonant structure, which generates time dependent axial electric fields to accelerate ions. When the rf field direction is reversed, the ion bunches are shielded from the decelerating fields by internal drift tubes. An "Interdigital-H"- type Linac operating at 101.28 MHz is planned.

1.1.3.3 Buncher Cavities

A resonant cavity in which the time dependent field in a gap is adjusted to decelerate the front of a beam bunch arriving at the gap, and accelerate the back of the bunch, so that all particles in the bunch arrive at a downstream point more closely spaced in time. By changing the phase of the cavity by 180 degrees relative to the bunch, it can be used to remove energy spread in the beam ("debuncher") instead.

Hazard Rating and Follow-up Assignments for Structural Components (E. Beebe and J. Alessi)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a high initial risk.

The following questions were answered YES and are considered a hazard rating of 3:

2c (1). Does this operation use RGDs that are built locally or are commercially available units that have been modified?

The following questions were answered YES and are considered a hazard rating of 2:

1b. Are any chemicals or chemical wastes used, stored or generated in this operation either known or suspected human carcinogens?
1d. Does this operation use, generate or store flammable or combustible gases, liquids or solids, including solvents?
1d(1). Does this operation involve the use of hydrogen gas?
1e. Does this operation involve the use, storage or generation of caustic/corrosive chemicals or wastes?
1h. Will this operation involve use of heavy metals such as mercury, silver, or cadmium?
2. Are there any accelerators or other radiation generating devices involved in this operation?
2b. Are there any radiation generating devices (RGD) used in this operation?

2c. Does the radiation generating device only produce radiation incidental to its primary function (such as electron microscopes, electron beam welders, ion implantation equipment)?
4a. Will this operation generate non-radioactive air emissions or effluents?
4c. Will ANY waste (radioactive, hazardous, mixed, sanitary, etc.) be produced as a result of this operation?
6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?
7k. Is any part of this system/operation involve a cryogenic system or dewar installation?
7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?
8e. Is there any radiofrequency or microwave field generated by a source greater than 7W in a space that might be occupied?8f. Does this equipment/operation produce any magnetic fields greater than 4 Gauss?
8l. Is there any possibility of creating an Oxygen Deficient Atmosphere?
11b. Will operation require work outside normal working hours?
11d. Will this operation require special attention in the event is left unexpectedly for long periods of time?
11e. Will this operation require an emergency procedure due to unusual or complicated shutdown instructions?
13. Are there any controls (i.e., ventilation, fume hoods, interlocks, personal protective equipment, HEPA filters/vacuum cleaners, medical monitoring) associated with this operation?
13b. Are interlocks used in this operation?
13c. Is any personal protective equipment used in this operation?
15. Are you aware of any other hazardous conditions or potential sources of hazards that have not previously been addressed by these questions that you feel deserve further consideration?

The following questions were answered YES and are considered a hazard rating of 1:

1. Are there any chemicals, toxic materials, or hazardous materials handled, generated, used, or stored in this operation, including oils and solvents?
1a. Does this operation use or transport any chemicals with a Threshold Limit Value, or chemical which is regulated by OSHA?
3. Are radioactive materials (including sealed sources and wastes) generated, handled, processed, used or stored?
3a. Does this operation involve handling of radioactive materials or sources?
4c. Is any waste generated from this operation?
7b. Does the operation include the use of hoist, crane, forklift, or rigging?
7e. Will you be purchasing any ladders or scaffolds?
7f. Will this operation require any elevated work?
7i. Does any equipment operate at pressures above 15 psig or under a vacuum?
7l. Does the operation include the use of typical shop equipment?
8h. Are there any surface temperatures less than 0 deg F or greater than 150 deg F?
10. Does this operation involve: the use of equipment, tools or materials outside of the design specifications or outside of the manufacturer's recommendations OR the use of equipment or apparatus not commercially available?
11. Will this operation require trained operators or close surveillance?
12e. Could this equipment act as an ignition source?

Follow-up Assignments (E. Beebe)

(1) Consult with Peter Cirnigliaro (x5636) and review the applicability of requirements in the Working with Chemicals SBMS Subject Area. This would apply to gases, uranium or any other source materials to be used. Implement a process that requires you to review source materials with Peter Cirnigliaro (x5636) before they are introduced to EBIS in the future. Review the use of uranium ions in EBIS with E. Lessard and initiate a change to the RHIC Accelerator Safety Envelope if required.

(1b) Carcinogen use automatically qualifies workers for enrollment in the Carcinogen medical monitoring program. See Peter Cirnigliaro (x5636) for more information or assistance in enrolling in the program.

(1d) For all flammable gases and liquids, a safe volume must not be exceeded. The safe volume is calculated by dividing the volume of the gaseous state of the flammable/combustible material by the total volume of the room and ensuring this number does not exceed ten percent of the lower flammability limit for the material. See Peter Cirnigliaro (x5636) for more information or assistance.

(1d1) When working with hydrogen, special requirements apply. At a minimum in the event of an emergency (total loss of containment) the percent of hydrogen gas in the room are cannot exceed 0.4% (Flammability range is 4-75%). Please include calculations or comments addressing this issue in the analysis for this operation. Present these calculations to the ASSRC. Contact Woody Glenn (x4770), Chair of the ASSRC.

(1e) Work with caustic/corrosive chemicals must be done in an area with an eyewash and shower. See Peter Cirnigliaro (x5636) for more information or assistance.

(1h) Use of heavy metals such as mercury, silver, or cadmium may involve special handling and training. See Peter Cirnigliaro (x5636) for more information or assistance.

(2a) Please list keV of accelerator and general operating guidelines in analysis. Have this accelerator reviewed by the Radiation Safety Committee (RSC). Please contact the RSC Chair, Dana Beavis (x7124).

(2b, 2c(1)) RGDs require that they be inventoried and that surveys be conducted annually. If your device is not accounted for or is not surveyed annually contact Paul Bergh (x5992). Also, note this registration in the analysis for your operation by the Radiation Safety Committee. Please contact the RSC Chair, Dana Beavis (x7124).

(3) Work with radioactive materials and source may require an RWP. Contact the FSS Representative, Paul Bergh (x5992).

(3a) If your operation uses radioactive sources, inventories are required. Include isotope and quantity. Contact Peter Cirnigliaro, C-AD Source Custodian (x5636).

(3f, 4d) Provide a list of all material being stored at Collider-Accelerator, and intended location. Contact Peter Cirnigliaro, C-AD Source Custodian (x5636).

(4c, 4c(1)) Waste generators must have proper training. Contact Joel Scott (x7520), Environmental Coordinator, for more information.

(4a, 4b) Operations involving air emissions or wastewater discharges require assessment to determine whether they meet current permit limits or require a permit. Contact Mel VanEssendelft (x2905), the Environmental Compliance Representative, for additional guidance.

(4c) Waste generators must have proper training. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

(7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. You need to ensure you add your equipment to the C-AD annual request for these services, notify Joel Scott (x7520).

(7b) Forklifts, powered trucks, platform lift trucks and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(7c) Any structures supporting heavy loads or structural changes to cranes or buildings requires review by the Plant Engineering Division and the Chief Mechanical Engineer. Contact Joe Tuozzolo (x3966) for a review.

(7e) Ladders must not be wooden. Scaffolding must be reviewed by the C-AD ESH Coordinator. Please contact Asher Etkin (x4006).

(7f) Elevated work may require fall protection and/or a fall protection plan. Consult with Peter Cirnigliaro (x5636).

(7i) The SHSD Safety Engineering Group, prior to use, must review pressure systems that operate at greater than 15 psig. Contact the ES&H Coordinator, Asher Etkin (x4006) for additional guidance. Note operating parameters in your analysis.

(7k) Inert cryogens greater than the safe volume in liters (calculated by dividing volume of workspace in cubic meters divided 14) and non-inert cryogens in quantities greater than 2 liters or 50 kg in the case of CO2 require review. Contact the ES&H Coordinator, Asher Etkin (x4006) for additional guidance. Note operating parameters in your analysis. Also, see the Oxygen Deficiency Hazard Subject Area for guidance. If safe volume has been calculated for your area include this information in the analysis for your operation.

(7l) Electrically powered hand tools should be double insulated and plugged into grounded system.

(7m) All sources of stored energy must be locked out or disabled prior to working on systems.

(8e, 8f) Non-ionizing radiation sources (NIR) sources must be listed on the C-A NIR inventory and may require measurements to be taken. If your equipment is not part of this inventory, please contact the ES&H Coordinator, Asher Etkin (x4006), for further guidance.

(8f) Any workers with pacemakers or medical implants require training, and may not be exposed to fields greater than 5 Gauss.

(8h) Surface with temperatures less than 0 deg F or greater than 150 deg F must be labeled, please contact the ES&H Coordinator, Asher Etkin (x4006), for further guidance.

(8l, 8m) The guidelines of SBMS Subject Area, Oxygen Deficiency Hazard should be followed.

(10) Please list the equipment that you are using outside of design specifications or manufacturer recommendations and/or locally built equipment in your analysis along with associated controls. Certification by the Chief Electrical and/or Chief Mechanical Engineer may be required. Contact Jon Sandberg (x4682) for electrical device review and Joe Tuozzolo (x3966) for mechanical device review.

(11) Ensure the operation of the EBIS magnet systems is incorporated into the C-AD Operations Procedure Manual Chapter 5, Linac, Booster, AGS and RHIC Startup Procedures. Contact Peter Ingrassia (x4272).

(11b, 11d, 11f) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required. Contact the QA Manager, Dave Passarello, x7277, to arrange for sign off on group procedures.

(11e) An emergency procedure must be developed in accordance with C-A OPM 3.0. Contact Peter Ingrassia (x4272).

(13a) Local ventilation systems must be certified annually as well as any time there is a modification/maintenance conducted on the system. See Peter Cirnigliaro (x5636) for more information or assistance.

(13b) A logbook of interlock checks should be maintained in the vicinity of the equipment.

(13c) All PPE requirements must be listed in your analysis. Special care must be given when selecting gloves. Always seek manufacture specific information on the gloves being used or contact the ESH Coordinator, Asher Etkin (x4006) for guidance.

(13c (1)) Ensuring proper gloves for chemicals that have the potential for skin absorption is critical to safety. Because gloves can be chemical specific, contact the ESH Coordinator, Asher Etkin (x4006) for further guidance and list the required type of gloves in the analysis for your operation.

The Following Facility Systems May Impact Your Operations

Be sure that these systems are mentioned in your analysis when you present the EBIS Project to the Accelerator Systems Safety Review Committee, contact Woody Glenn (x4770). Verify that the associated hazard controls are functional prior to beginning operations.

- Chilled Water
- De-Ionized/De-mineralized Water
- Electric Power (includes Grounding and UPS)
- Fire Protection
- Hoists and Cranes
- Heating Water
- Oxygen Monitoring System
- Public Address

Follow-up Assignments for RF Structures (J. Alessi)

(2b, 2c) RGDs require that they be inventoried and that surveys be conducted annually. If your device is not accounted for or is not surveyed annually contact Paul Bergh (x5992). Also, note this registration in the analysis for your operation by the Radiation Safety Committee. Please contact the RSC Chair, Dana Beavis (x7124).

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

(7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. You need to ensure you add your equipment to the C-AD annual request for these services, notify Joel Scott (x7520).

(7b) Forklifts, powered trucks, platform lift trucks and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(7i) The SHSD Safety Engineering Group, prior to use, must review pressure systems that operate at greater than 15 psig. Contact the ES&H Coordinator, Asher Etkin (x4006) for additional guidance. Note operating parameters in your analysis.

(8e, 8f) Non-ionizing radiation sources (NIR) sources must be listed on the C-A NIR inventory and may require measurements to be taken. If your equipment is not part of this inventory, please contact the ES&H Coordinator, Asher Etkin (x4006), for further guidance.

(8f) Any workers with pacemakers or medical implants require training, and may not be exposed to fields greater than 5 Gauss. Ensure all personnel are assigned the correct training requirements and that you have perform a magnetic safety review. Contact Peter Cirnigliaro (x5636) for a Static Magnetic Fields Hazard Assessment.

(11b) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required. Contact the QA Manager, Dave Passarello, x7277, to arrange for sign off on group procedures.

(13b) A logbook of interlock checks should be maintained in the vicinity of the equipment.

(13c) All PPE requirements must be listed in your analysis. Special care must be given when selecting gloves. Always seek manufacture specific information on the gloves being used or contact the ESH Coordinator, Asher Etkin (x4006) for guidance.

(13c (1)) Ensuring proper gloves for chemicals that have the potential for skin absorption is critical to safety. Because gloves can be chemical specific, contact the ESH Coordinator, Asher Etkin (x4006) for further guidance and list the required type of gloves in the analysis for your operation.

(15) For additional hazards that have not been addressed, please contact the ESH Coordinator, Asher Etkin (x4006), for help with reviewing these hazards and applying proper controls.

The Following Facility Systems May Impact Your Operations

Verify that the associated hazard controls are functional prior to beginning operations.

- Compressed Air
- Compressed Gas
- Chilled Water
- De-Ionized/De-mineralized Water
- Electric Power (includes Grounding and UPS)
- Fire Protection
- Hoists and Cranes
- Heating Water

- Oxygen Monitoring System
- Potable Water
- Sanitary Sewer
- Ventilation Supply/Exhaust

1.2 Controls (D. Barton)

Networked, front-end interfaces will be connected via Ethernet to control console workstations and central C-AD servers. Full pulse-to-pulse modulation functionality will be provided. Custom application software will be provided as needed, but extensive re-use will be made of existing software designs with EBIS database additions.

1.2.1 Timing & Infrastructure

C-AD fiber optic infrastructure will be extended to the EBIS equipment area and a standard network switch and timing chassis will be provided. Workstations and monitor screens will be provided for console-level control access, along with supporting software and database configuration.

1.2.2 EBIS

Waveform generation and data acquisition for EBIS will be provided using the fiber-optically isolated PSI interface and VME function generator. The fiber link interface of these standard C-AD modules will be modified to operate at 50 to 100 kHz for this application. Additional fiber optic links will carry pulsed trigger signals to the high voltage platforms. Standard VME chassis will be provided. Minor modifications will be required to existing front-end software for the function generator. A custom console application program will be developed for power supply waveform control.

1.2.3 Accelerators and Beam Transport

Commercial and C-AD standard VME modules will be used to control magnet power supplies and beam-line instrumentation. Standard VME chassis assembly and timing modules will be provided for these systems and for RF system interfaces. Front-end software effort will be mainly configuration and database setup. Existing console programs for beam line diagnostics will be modified to include the EBIS transport lines.

Hazard Rating and Follow-up Assignments for Controls (D. Barton)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following question was answered YES and is considered a hazard rating of 2:

6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?

Follow-up Assignments (D. Barton)

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

The Following Facility System May Impact Your Operation

Verify that the associated hazard controls are functional prior to beginning operations.

- Electric Power (includes Grounding and UPS)

1.3 Diagnostics/Instrumentation (M. Wilinski)

1.3.1 Faraday Cup

A fully destructive measurement is made when a detector head is plunged into the beam path to collect the entire ion beam. The captured charge is measured as a current in the processing electronics. Several types of detector heads can be employed depending on the characteristics of the desired measurement. Channeltrons or multichannel plates are used for fast high bandwidth response.

1.3.2 Current Transformers

A ferrite toroid wound with many turns of signal wire is positioned around a ceramic break in the beam transport, all enclosed in a protective shroud. This is used as a non-destructive technique to measure the ion beam current characteristics with respect to time. A separate set of wire turns on the toroid is used for injecting a calibration signal.

1.3.3 Profile Monitors

Transverse beam profiles are measured by plunging an array of thin wires into the beam path. Each of the wires collects the charge from the small portion of the ion beam it intercepts; this charge is detected as a current in the processing electronics.

Hazard Rating and Follow-up Assignments for Diagnostics/Instrumentation (M. Wilinski)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?
7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?

Follow-up Assignments (M. Wilinski)

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

(7m) All sources of stored energy must be locked out or disabled prior to working on systems.

The Following Facility System May Impact Your Operation

Verify that the associated hazard controls are functional prior to beginning operations.

- Electric Power (includes Grounding and UPS)

1.4 Magnet Systems (J. Ritter)

1.4.1 EBIS Warm Solenoids

The EBIS warm solenoids consist of three solenoid magnets. The electron gun solenoid is designed with water-cooled hollow conductors, pancake-style coils and no iron return. The electron gun coil provides the necessary field for proper electron beam launching and transport. The electron collector solenoid is similar in design to the electron gun solenoid. The electron collector solenoid focuses the beam to allow for proper electron collector operation. The remaining magnet, the LEBT solenoid, is a pulsed solenoid located directly in front of the RFQ. The LEBT solenoid focuses the EBIS beam into the RFQ. The design of the LEBT solenoid uses pancake coils with a laminated iron return similar in design to the BNL Optically Pumped Polarized Ion Source (OPPIS) LEBT solenoid.

1.4.2 MEBT Quadrupoles

The EBIS MEBT quadrupole magnets are used to provide the necessary focusing for beam transport between the RFQ output and the Linac input. The quadrupole magnets have been sent to BNL from Los Alamos National Laboratory, where they were released from the LEDA project. These LANL quadrupole magnets have half the magnetic length needed for the EBIS MEBT. To produce the required magnetic length, two quadrupole magnets will be positioned closely together around each of the four original quadrupole magnet positions. The estimate includes the support system of magnets and necessary water manifolds.

1.4.3 HEBT Dipoles

The HEBT dipoles are two similar 73° bending dipoles. The basic design of the dipoles is a C style with the open end facing the outer curve to allow the chamber to have a port for the Tandem-to-Booster (TTB) line into the Booster. The magnets will be constructed of laminations of different sizes which when assembled will produce the required bend shape. The magnet coils will be made of water-cooled hollow copper conductor.

1.4.4 HEBT Quadrupole Magnets

The HEBT quadrupoles will be air-cooled Danfysik magnets. Originally used for other projects at BNL, these magnets are available for the EBIS beam line. These magnets will allow switching of values in ~ 1 second for running of different magnetic rigidity beams.

Hazard Rating and Follow-up Assignments for Magnet Systems (J. Ritter)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk

- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?
7c. Are there any structures supporting heavy loads?
8f. Does this equipment/operation produce any magnetic fields greater than 4 Gauss?

The following questions were answered YES and are considered a hazard rating of 1:

7b. Does the operation include the use of hoist, crane, forklift, or rigging?
7l. Does the operation include the use of typical shop equipment?
11. Will this operation require trained operators or close surveillance?

Follow-up Assignments (J. Ritter)

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

(7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. You need to ensure you add your equipment to the C-AD annual request for these services, notify Joel Scott (x7520).

(7b) Forklifts, powered trucks, platform lift trucks and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(7c) Any structures supporting heavy loads or structural changes to cranes or buildings requires review by the Plant Engineering Division and the Chief Mechanical Engineer. Contact Joe Tuozzolo (x3966) for a review.

(7l) Electrically powered hand tools should be double insulated and plugged into grounded system.

(8e, 8f) Non-ionizing radiation sources (NIR) sources must be listed on the C-A NIR inventory and may require measurements to be taken. If your equipment is not part of this inventory, please contact the ES&H Coordinator, Asher Etkin (x4006), for further guidance.

(8f) Any workers with pacemakers or medical implants require training, and may not be exposed to fields greater than 5 Gauss. Ensure all personnel are assigned the correct training requirements and that you have perform a magnetic safety review. Contact Peter Cirnigliaro (x5636) for a Static Magnetic Fields Hazard Assessment.

(11) Ensure the operation of the EBIS magnet systems is incorporated into the C-AD Operations Procedure Manual Chapter 5, Linac, Booster, AGS and RHIC Startup Procedures. Contact Peter Ingrassia (x4272).

The Following Facility Systems May Impact Your Operation

Verify that the associated hazard controls are functional prior to beginning operations.

- Chilled Water
- De-Ionized/De-mineralized Water
- Electric Power (includes Grounding and UPS)
- Hoists and Cranes
- Heating Water
- Non-potable Water

1.5 Power Supply Systems (R. Lambiase)

1.5.1 EBIS

These are power supplies to support EBIS itself:

- Solenoid, cathode, cathode heater, collector and grid supplies
- Platform bias supplies and the transformers to isolate them
- Drift tube supplies, Behlke switches, and transverse magnetic supplies

1.5.2 External Ion Injectors and LEBT

These are power supplies to support two external ion sources, the transport from the ion sources to the LEBT, and the LEBT itself:

- Heater, arc pulser and extractor power grid supplies
- Platform bias supplies and the transformers to isolate them
- Supplies for electrostatic and electromagnetic steering elements and lenses
- Mass analyzer and focusing solenoid power supplies

1.5.3 MEBT, IH LINAC, and HEBT

These are power supplies for the MEBT, IH LINAC, and HEBT:

- Pulsed quadrupole magnets and steering magnet power supplies
- Linac drift tube quadrupole magnet power supplies
- Pulsed bending magnet power supplies

Hazard Rating and Follow-up Assignments for Power Supply Systems (R. Lambiase)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following question was answered YES and is considered a hazard rating of 2:

6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?

The following questions were answered YES and are considered a hazard rating of 1:

7b. Does the operation include the use of hoist, crane, forklift, or rigging?
11a. Will this operation be left unattended?

Follow-up Assignments (R. Lambiase)

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

(7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. You need to ensure you add your equipment to the C-AD annual request for these services, notify Joel Scott (x7520).

(7b) Forklifts, powered trucks, platform lift trucks and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(11a) If your operation will be left unattended and it poses a hazard to individuals who may enter the area for whatever reason then you must ensure that the area is posted with the name of the contact and phone number along with associated hazards when unattended. This information and instructions for a safe shutdown should be included in the analysis for your operation. Contact the Accelerator Systems Safety Review Committee Chair, Woody Glenn (x4770), to schedule a review of the systems prior to operations.

1.6 RF Systems (A. Zaltsman)

1.6.1 High Level RF

The final rf amplifier stages are powering the RFQ, Linac, and three bunchers. This includes the coaxial transmission line connecting the amplifier outputs to the rf cavities.

1.6.2 Low Level RF

These are low power rf systems that provide the phase and amplitude controls for the high level rf systems, and frequency control for the resonant cavities.

Hazard Rating and Follow-up Assignments for RF Systems (A. Zaltsman)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

8e. Is there any radiofrequency or microwave field generated by a source greater than 7 W in a space that might be occupied?
8f. Does this equipment/operation produce any magnetic fields greater than 4 Gauss?
8j. Is it required for personnel to work in an area with a Noise Level between 85 dBA and 100 dBA?
11b. Will operation require work outside normal working hours?
11d. Will this operation require special attention in the event is left unexpectedly for long periods of time?

Follow-up Assignments (A. Zaltsman)

(8e, 8f) Non-ionizing radiation sources (NIRs) must be listed on the C-A NIR inventory and may require measurements to be taken. If your equipment is not part of this inventory, please contact Asher Etkin, ES&H Coordinator, x4006, for further guidance.

(8f) Any workers with pacemakers or medical implants require training, and may not be exposed to fields greater than 5 Gauss.

(8j) If workers can be potentially exposed to excessive noise, contact Peter Cirnigliaro (x5636) for a noise evaluation.

(11b, 11d) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required. Contact the QA Manager, Dave Passarello, x7277, to arrange for sign off on group procedures.

(11e) An emergency procedure must be developed in accordance with C-A OPM 3.0. Contact Peter Ingrassia (x4272).

(13, 13b) A logbook of interlock checks should be maintained in the vicinity of the equipment.

(13c) All PPE requirements must be listed in your work planning documents. Special care must be given when selecting gloves. Always seek manufacture specific information on the gloves being used or contact the ESH Coordinator, Asher Etkin (x4006) for guidance.

1.7 Vacuum Systems (M. Mapes)

1.7.1 Beampipes/Chambers

These are pipes or chambers that have vacuum pressure inside and provide a path for the ion to be transported, as well as provide a housing for special components inside the vacuum system.

1.7.2 Vacuum Instrumentation & Control

A PLC-based control system is used to monitor and control the vacuum system and components such as gauges, pumps and valves.

1.7.3 Vacuum Pumps

These are pumps used to evacuate or pump down a vacuum chamber from atmospheric pressure to the desired high vacuum or ultra-high vacuum range.

1.7.4 Vacuum Valves

These are manual or pneumatically operated valves used to isolate vacuum pumps and/or a section of the beam line from another section or vacuum chamber.

Hazard Rating and Follow-up Assignments for Vacuum Systems (M. Mapes)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

1b. Are any chemicals or chemical wastes used, stored or generated in this operation either known or suspected human carcinogens?
1d. Does this operation use, generate or store flammable or combustible gases, liquids or solids, including solvents?
7k. Is any part of this system/operation involve a cryogenic system or dewar installation?
7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?

The following questions were answered YES and are considered a hazard rating of 1:

1. Are there any chemicals, toxic materials, or hazardous materials handled, generated, used, or stored in this operation, including oils and solvents?
7i. Does any equipment operate at pressures above 15 psig or under a vacuum?
7l. Does the operation include the use of typical shop equipment?

Follow-up Assignments (M. Mapes)

(1) Consult with Peter Cirnigliaro (x5636) and review the applicability of requirements in the Working with Chemicals SBMS Subject Area

(1b) Carcinogen use automatically qualifies workers for enrollment in the Carcinogen medical monitoring program. See Peter Cirnigliaro (x5636) for more information or assistance in enrolling in the program.

(1d) For all flammable gases and liquids, a safe volume must not be exceeded. The safe volume is calculated by dividing the volume of the gaseous state of the flammable/combustible material by the total volume of the room and ensuring this number does not exceed ten percent of the lower flammability limit for the material. See Peter Cirnigliaro (x5636) for more information or assistance.

(7i) The SHSD Safety Engineering Group, prior to use, must review pressure systems that operate at greater than 15 psig. Contact the ES&H Coordinator, Asher Etkin (x4006) for additional guidance. Note operating parameters in your analysis.

(7l) Electrically powered hand tools should be double insulated and plugged into grounded system.

(7k) Inert cryogens greater than the safe volume in liters (calculated by dividing volume of workspace in cubic meters divided 14) and non-inert cryogens in quantities greater than 2 liters or 50 kg in the case of CO2 require review by Ray Karol (x5272). See the Oxygen Deficiency Hazards Subject Area for guidance. If safe volume has been calculated for your area include this information in the analysis for your operation.

(7m) All sources of stored energy must be locked out or disabled prior to working on systems.

1.8 Cooling Systems (J. Scaduto)

The cooling system is comprised of three separate and independent closed loop systems that will run off the present Linac chilled water system and dissipate heat into the existing Linac cooling tower. Each system consists of individually skid-mounted components: a pump/motor, filter, heat exchanger, expansion tank, temperature and pressure control valves, and water treatment as required. The active on-line deionized water controls on two of the systems maintain the required resistivity. The exception is for the rf structures, which will have a 4109 iron corrosion inhibitor control system.

A chilled water source is required to supply the necessary 70 ^{0}F temperature. The existing Linac chilled water system is the preferred choice.

Hazard Rating and Follow-up Assignments for Cooling Systems (J. Scaduto)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

1b. Are any chemicals or chemical wastes used, stored or generated in this operation either known or suspected human carcinogens?
1e. Does this operation involve the use, storage or generation of caustic/corrosive chemicals or wastes?
4a. Will this operation generate non-radioactive air emissions or effluents?
4c. Will ANY waste (radioactive, hazardous, mixed, sanitary, etc.) be produced as a result of this operation?
4c2. Will this operation generate any hazardous wastes?
6b. Is it required for personnel to work on energized systems greater than 50V (Range A) but less than 600 V (Range B&C)?
7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?
8j. Is it required for personnel to work in an area with a Noise Level between 85 dBA and 100 dBA?
11b. Will operation require work outside normal working hours?

The following questions were answered YES and are considered a hazard rating of 1:

1. Are there any chemicals, toxic materials, or hazardous materials handled, generated, used, or stored in this operation, including oils and solvents?
1a. Does this operation use or transport any chemicals with a Threshold Limit Value, or chemical that is regulated by OSHA?
4c. Is any waste generated from this operation?
11. Will this operation require trained operators or close surveillance?

Follow-up Assignments (J. Scaduto)

(1) Consult with Peter Cirnigliaro (x5636) and review the applicability of requirements in the Working with Chemicals SBMS Subject Area

(1b) Carcinogen use automatically qualifies workers for enrollment in the Carcinogen medical monitoring program. See Peter Cirnigliaro (x5636) for more information or assistance in enrolling in the program.

(1e) Work with caustic/corrosive chemicals must be done in an area with an eye wash and shower.

(4a, 4b) Operations involving air emissions or wastewater discharges require assessment to determine whether they meet current permit limits or require a permit. Contact Mel VanEssendelft (x2905), the Environmental Compliance Representative, for additional guidance.

(4c) Waste generators must have proper training. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6b, 6c) Working On or Near Energized Conductors training is required for work on energized equipment. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(7m) All sources of stored energy must be locked out or disabled prior to working on systems.

(8i, 8j, 8k) If workers can be potentially exposed to excessive noise, contact Peter Cirnigliaro (x5636) for a noise evaluation.

(11) Ensure the operation of the EBIS magnet systems is incorporated into the C-AD Operations Procedure Manual Chapter 5, Linac, Booster, AGS and RHIC Startup Procedures. Contact Peter Ingrassia (x4272).

(11b) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required. Contact the QA Manager, Dave Passarello, x7277, to arrange for sign off on group procedures.

The Following Facility Systems May Impact Your Operations

Verify that the associated hazard controls are functional prior to beginning operations.

- Compressed Air
- Chilled Water
- De-Ionized/De-mineralized Water
- Electric Power (includes Grounding and UPS)
- Fire Protection
- Process Cooling Water
- Sanitary Sewer
- Steam

1.9 Facility Modifications (A. Pendzick)

1.9.1 Beam Access Port, Exit Door From Linac and Vertical Ports Into Booster Tunnel

A new access port for the EBIS beam line will be installed through the earth shielding from Linac to the Booster.

A new exit door from the upper equipment bay at Linac will exit onto a staircase on the Booster berm, approximately 20 feet into the Booster radiation area.

The present plan is to install two 8" vertical ports through the top of the Booster tunnel in the "C" area to power the dipoles in the EBIS beam line.

1.9.2 Power modification

This modification provides for the relocation of existing power and tray in the Linac area where the EBIS beam line will be installed.

Hazard Rating and Follow-up Assignments for Facility Modifications (A. Pendzick)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

2. Are there any accelerators or other radiation generating devices involved in this operation?
3d. Will any radioactive material/waste be transported as a result of this operation?
4c. Will ANY waste (radioactive, hazardous, mixed, sanitary, etc.) be produced as a result of this operation?
4c1. Will this operation generate any radioactive waste?
7c. Are there any structures supporting heavy loads?
7d. Does this operation require a structural change to any crane or building?
7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?
13. Are there any controls (i.e., ventilation, fume hoods, interlocks, personal protective equipment, HEPA filters/vacuum cleaners, medical monitoring) associated with this operation?
13c. Is any personal protective equipment used in this operation?

The following questions were answered YES and are considered a hazard rating of 1:

3. Are radioactive materials (including sealed sources and wastes) generated, handled, processed, used or stored?
3a. Does this operation involve handling of radioactive materials or sources?
4c. Is any waste generated from this operation?
7b. Does the operation include the use of hoist, crane, forklift, or rigging?

Follow-up Assignments (A. Pendzick)

(2) Installation of new penetrations into the Linac or Booster must be reviewed by the Radiation Safety Committee (RSC). Contact the RSC Chair, Dana Beavis, x7124.

(3) Work with radioactive materials and source may require an RWP. Contact the FSS Representative, Paul Bergh (x5992).

(3a) If your operation uses radioactive sources, inventories are required. Include isotope and quantity. Contact Peter Cirnigliaro, C-AD Source Custodian (x5636).

(3d) The transportation of radioactive materials is strictly controlled at Brookhaven National Laboratory. Contact Joel Scott (x7520), Environmental Coordinator, for more information.

(4c, 4c(1)) Waste generators must have proper training. Contact Joel Scott (x7520), Environmental Coordinator, for more information.

(7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. You need to ensure you add your equipment to the C-AD annual request for these services, notify Joel Scott (x7520).

(7b) Forklifts, powered trucks, platform lift trucks and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(7c, 7d) Any structures supporting heavy loads or structural changes to cranes or buildings requires review by the Plant Engineering Division and the Chief Mechanical Engineer, Joe Tuozzolo (x3966).

(7m) All sources of stored energy must be locked out or disabled prior to working on systems.

(8i, 8j, 8k) If workers can be potentially exposed to excessive noise, contact Peter Cirnigliaro (x5636) for a noise evaluation.

(13c) All PPE requirements must be listed in your work planning documents. Special care must be given when selecting gloves. Always seek manufacture specific information on the gloves being used. Contact Peter Cirnigliaro, C-AD Work Control Manager (x5636) for guidance.

(13c(1)) Ensuring proper gloves for chemicals that have the potential for skin absorption is critical to safety. Because gloves can be chemical specific, contact Peter Cirnigliaro, C-AD Work Control Manager (x5636) for guidance.

1.10 Installation (L. Snydstrup)

The major systems and components of the EBIS are installed at the facility site in building 930, including structural components, control systems, diagnostic and instrumentation systems, magnets, power supplies, RF systems, vacuum systems, and cooling systems. The installation effort also includes any minor additions or changes to the building and facility necessary to accommodate these systems and components.

1.10.1 Structural Components

The major structural components installed in the facility include the Electron Beam Ion Source (EBIS), RFQ and Linac. Other components will include smaller devices located in the LEBT, MEBT and HEBT beam transport regions, such as auxiliary ion sources (LEBT), bunchers, electrostatic beam transport devices and beam monitoring devices.

1.10.2 Controls

This includes installation of controls for the entire project.

1.10.3 Diagnostics/Instrumentation

This includes installation and checkout of all diagnostics in the beam lines.

1.10.4 Magnet Systems

This includes installation of the magnet systems installed in the beam transport line, which are dipole, quadrupole, solenoidal and steerer magnets. This work also includes survey of elements.

1.10.5 Power supply Systems

This includes installation of all power supplies in their final locations, the connection of power from breaker boxes to the supplies and the connections from the power supplies to the elements.

1.10.6 RF Systems

This includes installation of the rf power supplies, as well as the connection of the coaxial transmission line between the rf amplifiers and the rf cavities.

1.10.7 Vacuum Systems

This includes installation of beam pipes, chambers, pumps, and valves. This work also includes leak checking and bake out of systems.

1.10.8 Cooling Systems

This includes installation of all cooling systems.

Hazard Rating and Follow-up Assignments for Installation (L. Snydstrup)

Explanation of Hazard Rating

- 0 indicates an operation with minimal risk
- 1 indicates an operation with low initial risk
- 2 indicates an operation with moderate initial risk
- 3 indicates an operation with a high initial risk

Because of the hazards identified, this operation has the potential of being an operation with a moderate initial risk.

The following questions were answered YES and are considered a hazard rating of 2:

1g. Will this operation involve more than 30 minutes handling time with lead?
4c. Will any waste (radioactive, hazardous, mixed, sanitary, etc.)be produced as a result of this operation?
6b. Is it required for personnel to work on energized systems greater than 50 V (Range A) but less than 600 V (Range B&C)?
6d. Has this equipment been built locally, modified or not listed by a Nationally Recognized Testing Laboratory?
7c. Are there any structures supporting heavy loads?
7k. Is any part of this system /operation involve a cryogenic system or dewar installation?
7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?
8f. Does this equipment/operation produce any magnetic fields greater than 4 Gauss?
11b. Will operation require work outside normal working hours?
12d. Will this operation change the risk level of fire protection?
13. Are there any controls (i.e., ventilation, fume hoods, interlocks, personal protective equipment, HEPA filters/vacuum cleaners, medical monitoring) associated with this operation?
13c. Is any personal protective equipment used in this operation?
15. Are you aware of any other hazardous conditions or potential sources of hazards that have not previously been addressed by these questions that you feel are deserving of further consideration?

The following questions were answered YES and are considered a hazard rating of 1:

1. Are there any chemicals, toxic materials or hazardous materials handled, generated, used or stored in this operation, including oils and solvents?
4c. Is any waste generated from this operation?
7b. Does the operation include the use of hoist, crane, forklift, or rigging?
7f. Will this operation require any elevated work?
7l. Does the operation include the use of typical shop equipment?

11. Will this operation require trained operators or close surveillance?
11c. Will this operation require the 2-person rule?

Follow-up Assignments (L. Snydstrup)

(1) Consult with Peter Cirnigliaro (x5636) and review the applicability of requirements in the Working with Chemicals SBMS Subject Area.

(1g) Air monitoring is required for lead handling of more than 30 minutes. Respiratory protection may also be required. Consult with Peter Cirnigliaro (x5636).

(4c) Waste generators must have proper training. Contact Joel Scott (x7520), Environmental Coordinator, for more information.

(6) All personnel working with electrical systems must have Electrical Safety and Lockout/Tagout training. It is your responsibility to ensure all personnel are trained prior to working. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6b, 6c) Working On or Near Energized Conductors training is required for work on energized equipment. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(6d) The Chief Electrical Engineer must certify devices that are not commercially available. Contact Jon Sandberg (x4682).

(7b) Before using hoist, cranes or rigging equipment, ensure that current, valid annual inspection tags are attached. You need to ensure you add your equipment to the C-AD annual request for these services, notify Joel Scott (x7520).

(7b) Forklifts, powered trucks, platform lift trucks and motorized hand trucks require special training prior to use and require completion of a pre-use inspection. Contact the Training Manager, John Maraviglia (x7343), to ensure all personnel are assigned the correct training requirements.

(7c, 7d) Structures supporting heavy loads or structural changes to cranes or buildings requires review by the Plant Engineering Division and the Chief Mechanical Engineer, Joe Tuozzolo (x3966).

(7f) Elevated work may require fall protection and/or a fall protection plan. Consult with Peter Cirnigliaro (x5636).

(7l) Electrically powered hand tools should be double insulated and plugged into grounded system.

(7k) Inert cryogens greater than the safe volume in liters (calculated by dividing volume of workspace in cubic meters divided 14) and non-inert cryogens in quantities greater than 2 liters or 50 kg in the case of CO2 require review by Ray Karol (x5272). See the Oxygen Deficiency Hazards Subject Area for guidance. If safe volume has been calculated for your area include this information in the analysis for your operation.

(7m) All sources of stored energy must be locked out or disabled prior to working on systems.

(8f) Any workers with pacemakers or medical implants require training, and may not be exposed to fields greater than 5 Gauss. Ensure all personnel are assigned the correct training requirements and that you have perform a magnetic safety review. Contact Peter Cirnigliaro (x5636) for a Static Magnetic Fields Hazard Assessment.

(11) Ensure the operation of the EBIS magnet systems is incorporated into the C-AD Operations Procedure Manual Chapter 5, Linac, Booster, AGS and RHIC Startup Procedures. Contact Peter Ingrassia (x4272).

(11b) Internal group operational procedures must be developed for normal operations, and a list of trained personnel is required. Contact the QA Manager, Dave Passarello, x7277, to arrange for sign off on group procedures.

(11c) In your procedures, delineate any tasks that require a two-person rule as a control.

(12c,12d) Any deviations from Life Safety Code or change in the risk level of fire protection m must be approved by the Fire Protection Engineer. Contact Michael Kretchmann (x5274).

(13c) All PPE requirements must be listed in your analysis. Special care must be given when selecting gloves. Always seek manufacture specific information on the gloves being used or contact the ESH Coordinator, Asher Etkin (x4006) for guidance.

(15) Please review the additional hazard of “working with multiple groups” with the C-AD Work Control Manager, Peter Cirnigliaro (x5636).

Appendix 1: Questions Used in the Collider-Accelerator Department's Hazard Identification Tool

1. Are there any chemicals, toxic materials or hazardous material handled, generated, used, or stored in this operation, including oils and solvents?

1a. Does this operation use or transport any chemicals with a Threshold Limit Value, or chemical that is regulated by OSHA?

1b. Are any chemicals or chemical wastes used, stored or generated in this operation either known or suspected human carcinogen?

1c Does this operation involve the use, storage or generation of peroxide forming chemicals, shock sensitive chemicals or picric acid?

1d. Does this operation use, generate or store flammable or combustible gases, liquids or solids, including solvents?

1d (1). Does this operation involve the use of hydrogen gas?

1e. Does this operation involve the use, storage or generation of caustic/corrosive chemicals or wastes?

1f. Will this operation involve the use of beryllium - other than articles made of beryllium or that contain beryllium?

1g. Will this operation involve more than 30 minutes handling time with lead? Will this operation involve use of heavy metals such as mercury, silver or cadmium?

1i. Does this operation involve the use or transportation of explosives or explosive wastes?

2. Are there any accelerators or other radiation generating devices involved in this operation (other than the Collider-Accelerator)?

2a. Is there an accelerator used in this operation?

2a (1). Does this operation use accelerators that are built locally or are commercially available units that have been modified?

2b. Are there any radiation generating devices (RGD) used in this operation?

2b(1). Are radiation generating devices capable of creating a High Radiation Area (>100 mrem/hr at 30 centimeters)?

2b(2). Are the radiation generating devices capable of creating a radiation area?

2c. Does the radiation generating device only produce radiation incidental to its primary function (such as electron microscopes, electron beam welders, ion implantation equipment)?

2c(1). Does this operation use RGDs that are built locally or are commercially available units

that have been modified?

2d. Is the radiation generating device an intentional x-ray generating device which produces radiation as part of the primary function (i.e. x-ray diffractometers, x-ray machines)?

2d (1). Is the device built locally or been modified OR is it being used outside design specifications?

3. Are radioactive materials (including sealed sources and wastes) generated, handled, processed, used or stored?

3a. Does this operation involve handling of radioactive materials or sources?

3b. Does this operation involve radionuclides listed in the Radionuclide Threshold Table in amounts that exceed 10% of the quantity listed?

3c. Is dispersible radioactive material being used in this operation?

3d. Will any radioactive material/waste be transported as a result of this operation?

3e. Does this operation involve any accountable sources? (Sealed Radioactive Source Accountability Table)

3f. Any radioactive material being left or stored at Collider-Accelerator facilities?

4. Are there any possible environmental impacts with this operation?

4a. Are there any non-radioactive emissions or effluents from this operation?

4b. Are there any radioactive emissions or effluents from this operation?

4c. Is any waste generated from this operation?

4c(1). Is the waste radioactive?

4c(2). Is the waste hazardous?

4c(3). Is the waste mixed waste?

4d. Are any hazardous materials (such as lead, mercury or beryllium) being left or stored at Collider-Accelerator facilities?

4e. Does this operation require any new above or under ground storage tanks?

4f. Does this operation use ozone depleting substances?

4g. Are any changes required to the Environmental Management System (as determined by the Environmental Compliance Rep)?

4h. Is this work being done within 1/2 mile of the Peconic River?

5. Does this operation involve the use of lasers?

5a. Do personnel use or have the potential to be exposed to Class IV lasers?

5b. Do personnel use or have the potential to be exposed to Class IIIb lasers?

5c. Does the operation involve Class I, II or IIIa lasers?

5d. Does this operation involve Class I lasers with embedded IIIb or IV lasers?

5e. Have any of the lasers involved in this operation been built locally or have any commercially available lasers been modified?

5f. Is the laser registered at BNL with the Laser Safety Officer?

6. Is any energized electrical equipment used in this operation?

6a. Is there any exposed electrical components where there is the potential for personnel to be exposed to voltages greater then 50V (Range A)?

6b. Is it required for personnel to work on energized systems greater than 50 V (Range A) but less than 600 V (Range B&C)?

6c. Is it required for personnel to work on energized systems greater than 600 V (Range D)?

6d. Has this equipment been built locally, modified or NOT listed by a Nationally Recognized Testing Laboratory?

6e. Does your operation require the development of an Electrical Working On or Near Energized Conductors Permit?

6f. Are emergency shut-off controls provided for shutting down electrical power?

6g. Is required fusing provided for all relevant equipment?

7. Are there any mechanical hazards or work hazards such as material handling, elevated work, vacuum or pressure vessels, scaffolds, stored energy or structural considerations?

7a. Are there any material handling devices including all large moving equipment?

7b. Does the operation include the use of a hoist, crane, forklift, or rigging?

7c. Are there any structures supporting heavy loads?

7d. Does this operation require a structural change to any crane or building?

7e. Will you be purchasing any ladders or scaffolds?

7f. Will this operation require any elevated work?

7g. Does work require fall protection equipment (i.e. harness, lanyard)?

7h. Does the operation include the use of hydraulic or pneumatic lift?

7i. Does any equipment operate at pressures above 15 psig or under a vacuum?

7j. Does this system have any vacuum windows?

7k. Is any part of this system/operation involve a cryogenic system or dewar installation?

7l. Does the operation include the use of typical shop equipment?

7m. Are there any sources of stored energy (hydraulic, pneumatic, thermal, mechanical)?

7m1. Is the source capable of being easily isolated or can it be LOTO'd?

7m2. Is disassembly required to isolate energy (i.e. inserting blank flange)?

8. Does this operation require work with or generate any of the following physical hazards--confined spaces, RF or microwave radiation, magnetic fields, hot or cold surfaces, high noise levels, or oxygen deficiency?

8a. Does this operation create any space that might meet the definition of a confined space?

8b. Is it required for personnel to enter any Class 1 Confined Spaces?

8c. Is it required for personnel to enter any Class 2A or 2B Confined Spaces?

8d. Is it required for personnel to enter any Class 2C Confined Spaces?

8e. Is there any radiofrequency or microwave field generated by a source greater than 7W in a space that might be occupied?

8f. Does this equipment/operation produce any magnetic fields greater than 4 Gauss?

8g. Is it required for any personnel to be exposed to a magnetic field greater than 600 Gauss?

8h. Are there any surface temperatures less than 0 deg F or greater than 150 deg F?

8i. Does this operation generate any equipment which could operate at greater than 80 dbA?

8j. Is it required for personnel to work in an area with a Noise Level between 85-100 dBA?

8k. Is it required for personnel to work in an area with a Noise Level above 100 dBA?

8l. Is there any possibility of creating an Oxygen Deficient Atmosphere?

8m. Is it required for any personnel to work in an existing Oxygen Deficiency Hazard Area?

9. Are there any additional hazards, not mentioned above, that should be considered? Such as biological hazards, ergonomics or heat stress?

9a. Could a worker be exposed to any biological hazard including handling of human body fluids, human tissues, or mouse droppings?

9b. Will personnel perform functions that involve repetitive motion, excessive force or

vibration, lifting, or other ergonomic concerns?

9c. Will personnel be required to perform this operation in extreme climates or temperatures?

10. Does this operation involve the use of equipment, tools or materials outside of the design specifications or outside of the manufacturer's recommendations OR the use of equipment or apparatus not commercially available?

10a. Has this equipment received review by the C-A Chief Mechanical Engineer and/or Chief Electrical Engineer?

10b. Was this equipment built at a University or Laboratory in another country?

11. Will this operation require trained operators or close surveillance?

11a. Will this operation be left unattended?

11b. Will operation require work outside normal working hours?

11c. Will this operation require 2-person rule?

11d. Will this operation require special attention in the event it is left unexpectedly for long periods of time?

11e. Will this operation require an emergency procedure due to unusual or complicated shutdown instructions?

11f. Will group operational procedures be required for normal operation of this equipment?

11g. Is there a list of designated and trained personnel for this equipment/operation?

11h. During construction, use, or storage of spare parts and materials, are valuable materials attractive for theft and worth more than $1000 (e.g. precious metals; or copper, platinum, tungsten, stainless, aluminum) involved with this project?

12. Are there any fire protection or life safety concerns in this operation?

12a. Will welding or cutting or spark/flame producing operations be conducted in association with this operation?

12b. Does this operation generate, store or use any combustible materials in significant quantities?

12c. Will this operation require a deviation from the Life Safety Code (consider changes in exits, change in occupancy?

12d. Will this operation change the risk level of fire protection?

12e. Could this equipment act as an ignition source?

13. Are there any engineering controls or Personal Protective Equipment (PPE) required (i.e., ventilation, fume hoods, interlocks, HEPA filters/vacuum cleaners, respirators)?

13a. Is any local ventilation used in this operation?

13b. Are interlocks used in this operation?

13c. Is any personal protective equipment used in this operation?

13c(1) Are gloves used in this operation?

13d. Are HEPA filters in place/used?

13d(1). On ventilation systems?

13d(2). HEPA vacuum cleaners?

13e. Will respiratory protection be required for this operation?

14. Do you rely on any facility utilities (listed as sub questions) to provide safety controls for your operations?

14a. Compressed Air

14b. Compressed Gas

14c. Chilled Water

14d. De-Ionized/De-mineralized Water

14e. Electric Power (includes Grounding and UPS)

14f. Emergency electrical power

14g. Fire Protection

14h. Hoists and Cranes

14i. Heating Water

14j. Non-potable Water

14k. Oxygen Monitoring System

14l. Public Address

14m. Potable Water

14n. Process Cooling Water

14o. Sanitary Sewer

14p. Steam

14q. Utility Gas (natural gas)

14r. Vacuum

14s. Ventilation Supply/Exhaust

15. Are you aware of any other hazardous conditions or potential sources of hazards that have not previously been addressed by these questions that you feel deserve further consideration?